

MANAGEMENT INFORMATION SERVICE

REPORT NUMBER 16
May-'46

INTERNATIONAL CITY MANAGERS' ASSOCIATION 1313 EAST 60TH STREET - CHICAGO 37, ILLINOIS

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Route To:

Return To:

ANALYZING FIRE COMPANY MANPOWER REQUIREMENTS

How many fire fighters are required by the National Board's Grading Schedule?
How can good protection best be obtained with fewer men?

Many administrators have long wanted a reasonable criteria for estimating over-all fire department manpower requirements for their city. Many cities have found that National Board of Fire Underwriters Grading Schedule requirements, however desirable as a measure of optimum requirements, are economically unobtainable in practice. The manpower schedules might be met in most cities if they were based upon total fire company manpower on and off duty, rather than just the number of men in the stations ready to respond with the apparatus.

The Grading Schedule formulas indicate the number of fire companies usually required for cities of various population classifications. It is pointed out that these requirements are merely typical and will be influenced by local circumstances of area, topography, fire hazards, etc. The average Grading Schedule requirements for fire companies are:

Population	No. Pumper Cos.	No. Ladder Cos.	Total Cos.
25,000	4	2	6
50,000	7	3	10
100,000	10	4	14
150,000	14	6	20

In addition to indicating the number of fire companies required in a typical city based upon population, the schedule specifies the minimum manpower that must be on duty to man these companies. These manpower requirements vary considerably as to whether in the judgment of underwriters' engineers a particular fire company should be classed as a high-value district company or a residential or low-value district. As will be pointed out later, manpower requirements are higher for the companies classified as "high-value." Because of this element of judgment it has been found almost impossible to develop an accurate yardstick of manpower requirements for fire fighting personnel. However, a review of fire company classification as to high-value or low-value districts in several hundred cities of over 25,000 population indicates what is a reasonable number of high-value district (heavily manned) fire companies.

In the smaller cities (approximately 25,000 population) the headquarters engine and ladder company will usually require high-value manning. The other required companies will get by with low-value manning. The city of 50,000 population will require at least two engine companies and one ladder or "truck" company with high-value manning to provide good protection for principal mercantile and industrial areas. A city of 100,000 population will be likely to require at least three high-value engine companies and two high-value ladder companies. A city of 150,000 population may be considered to require at

(OVER)

least four high-value engines. This may be considerably higher depending upon local conditions and ladder company requirements may be less where structural heights are lower. Southern and western cities in general maintain fewer ladder companies than cities in the north and east, but their larger areas may require more engine companies in residential districts. On this basis the following table is evolved as a basis for this manpower study:

Population	Type of Fire Company Required			
	High-Value Engine	Low-Value Engine	High-Value Ladder	Low-Value Ladder
25,000	1*	3	1	1
50,000	2	5	1	2
100,000	3	7	2	2
150,000	4	10	3	3

Grading schedule requirements for manpower on duty call for the following strengths obtained from an average of day and night requirements:

High-value engines - 7 men High-value ladder - 7 men
 Low-value engines - 5 men Low-value ladder - 6 men

Next it is possible to estimate on-duty fire fighting personnel requirements for typical cities on a population basis:

Typical Grading Schedule Requirements								
Popu- lation	Total Required Companies		H.V. Eng	L.V. Eng.	H.V. Lad.	L.V. Lad.	Required Men on Duty	
	Eng.	Lad	Cos. Men	Cos. Men	Cos. Men	Cos. Men	Men	35
25,000	4	2	1	17	3	15	1	6
50,000	7	3	2	14	5	25	1	12
100,000	10	4	3	21	7	35	2	12
150,000	14	6	4	28	10	50	3	18

However, firemen no longer work continuously with little or no relief so that the above figures for required manpower on duty fall far short of required fire fighter personnel. In most fire departments there are two platoons (84 hours a week). Others operate under various systems limiting hours of work to 72, 70, 64 hours or less. This study excludes the three platoon system or 48 hour week which would require additional manpower and would be a subject of special study. This study is based upon a 72-hour week which probably is typical of the postwar fire departments in cities of under 250,000 population.

In addition to the men on duty on each shift of the fire department extra strength must be allowed for days off on a weekly or monthly basis and allowance must be made for substitutes for vacations and for sick leave and leave for injuries. In addition there must be chief officers on duty at all

* Note: In many small cities no high value manning will be required. This merely presents a typical situation in each population group.

times with their drivers and aides. In some departments the chiefs' aides are credited to a fire company but this is purely a fiction as far as their duties are concerned. This study is limited strictly to fire fighting personnel exclusive of fire prevention bureau, maintenance, and fire alarm services, although fire company members usually perform routine inspections in their districts. Thus, over-all fire fighter requirements may be set-up in the following manner:

Population	Required Total Fire Fighters						Total Fire Fighting Personnel*
	Required	Officers	Relief	Relief for Vacations	and Sick Leave		
	Men on Duty	2-Platoons and Their Aides †	Men to Provide Days Off				
25,000	35	70	2	10	7		89
50,000	58	116	6	17	11		150
100,000	82	164	12	25	16		217
150,000	127	254	14	39	24		331

The above data show how many fire fighters will be required to meet typical Grading Schedule requirements. What do these figures mean when applied to the average city? According to Census Bureau data for 1940 the number of males in urban communities between the ages of 20 and 64 years amounted to only 307 per 1,000 urban population. These are approximately the ages of men in the fire service and comprise the total male wage earners in the city. Applied to cities of different sizes, on the basis of the Grading Schedule, the result is as follows:

Total Population	Required Fire Fighters	Fire Fighters per 1,000 Pop.	Total Male Population (20-64 yrs)	Required F.F. per 100 males (20-64 yrs)	Ratio of Required Fire Fighters to Men of Working Age
25,000	89	3.55	7,700	1.15	1 to 86
50,000	150	3.00	15,400	0.97	1 to 103
100,000	217	2.17	30,700	0.71	1 to 141
150,000	331	2.20	46,100	0.72	1 to 139

While a few of the more powerful fire departments in the larger cities may approach two firemen per 1,000 population, it would be almost impossible for cities of 50,000 or less to provide the three or more men per 1,000 population called for by Grading Schedule company distribution and manpower requirements, particularly where this would require better than one fireman for every 100 male wage earners in the community.

* No consideration is given to the manning of special equipment.

† The minimum requirements for officers above company rank would be a chief and an assistant chief who would alternate on duty. In the smallest departments the chief's would not have aides, but in cities of 50,000 there would be a chief, an assistant or deputy chief on each platoon, with an aide for each chief. In the larger cities companies are grouped into districts or battalions with a chief officer and aide on duty in each area on each shift in addition to the chief and deputy chiefs over the entire department.

If grading schedule requirements are unobtainable, what is a good yard-stick of reasonable fire department strength? One answer, based upon an observation of many communities, is that fair to good protection can be obtained by a fire force approximating 1.5 men per 1,000 inhabitants where firemen work 64 to 72 hours a week, and by 1.3 to 1.4 men per 1,000 inhabitants where firemen work 84 hours a week. Below these figures company unit distribution and fire company manpower are usually too deficient for most effective operation at serious fires although minor outbreaks may be handled with fair success in many cases.

In obtaining best utilization of manpower with a 1.5 or less ratio per 1,000 population, it will usually be desirable to maintain a slightly smaller number of engine and ladder company units than called for by the Grading Schedule in order that individual companies may be maintained at fairly high efficiency. Exceptions are cities having large areas of scattered residential properties which must be protected even though the manning of out-lying companies is much smaller than would be desirable. The following table shows how good protection can be maintained with 1.5 men per 1,000 where a city cannot afford to provide the full Grading Schedule requirements:

Suggested Reduction in Number of Fire Companies

Population	Grading Schedule		Reduced to Meet Lower Available Manpower		Total Fire Fighters in 1.5 per 1,000 Pop. Ratio
	Engines	Ladders	Engines	Ladders	
25,000	4	2	3	1	37
50,000	7	3	5	2	75
100,000	10	4	8	3	150
150,000	14	6	12	5	225

It should be kept in mind that in many cases the importance of individual fire companies has become a fiction particularly where many of the companies respond to alarms with skeleton crews which are unable to utilize the costly equipment provided. In general, scattered neighborhood fire companies give but weak protection only to their immediate part of the city. Fewer well-manned companies should be provided at locations which make them available to the maximum areas permissible under the Grading Schedule's distance requirements which permit runs of $1\frac{1}{2}$ miles in residential districts and three miles in scattered residential districts for engine companies.

In the city of 25,000 population these would have approximately 37 fire fighters, of whom two would be chief officers. The remaining 35 men could provide the following minimum manning: Three engines, 4 men each, and a minimum of 3 men on the ladder truck. It is suggested that one engine and the ladder truck would be located at headquarters giving a minimum response of 7 men from that station. As at least two pumper companies and a ladder company are required for first alarms in cities under 50,000 population the minimum response would be a dozen men and a chief officer and one company would remain in quarters for a second fire. A total of 16 men would be on duty at all times.

Some critics will point out that the ladder company manpower suggested here is seriously deficient as 6 men are needed to raise the longest manual

May-46

- 5 -

ladder. This may be true when judged by big city standards but it may be pointed out that the average small department does not use the longest manually raised ladder at fires once in five or ten years, that modern power-operated aerial ladders controlled by one or two men are standard equipment in even the smallest cities, and that ladder companies are auxiliary units and always accompany engine companies.

As a matter of fact, many persons feel that the ladder company manpower requirements of the Grading Schedule are needlessly severe when compared with engine company requirements. A six-man minimum crew should be adequate for high-value ladder companies and five men for ladder companies in residential districts.

A city of 50,000 population having 75 fire fighters might maintain the following minimum company strengths: A headquarters station engine company in the high-value district would have 6 men on duty; four other engine companies and two ladder companies would have four men each. The department would have three chiefs, each with an aide. Response to first alarms in the high-value district would be three engines and a ladder company with a minimum of 20 men including a chief and aide. Two engines, and a ladder company with 12 men would remain in quarters. It should be appreciated that these figures are minimum as allowances have been made for off shift, vacations, sick leaves, etc. The actual number of men needed for a company with four on duty would be approximately ten.

If the above suggested strengths for cities of 25,000 and 50,000 seem weak as compared with usual fire company strength of larger cities, it should be recalled that Grading Schedule requirements are most unobtainable when applied against these smaller cities which cannot afford to maintain a powerful manual fire force for infrequent large fires. The organization suggested provides good response to alarms and reasonable coverage for a second fire. Where unusual situations occur the off-shift can be called in to man reserve apparatus which should be provided for every fire department and to utilize more fully the partially manned companies already at the fire.

In cities of 100,000 stronger fire company manning is needed and can be provided at the suggested 1.5 ratio per 1,000 population. Cities of 100,000 population would have 142 fire fighters, deducting officers and aides. Such cities will need to maintain at least two high-value engine companies and a headquarters ladder company with 6 men on duty in each. This figure is one less per shift than recommended by the Grading Schedule for high-value units but it is a true minimum figure. Six other engine companies and two other ladder companies would have minimum manning of five men each. Required response at night in the high-value district would be four engines and two ladder trucks with a minimum of 35 officers and men, a truly formidable force. Remaining in quarters would be four engines and one ladder company with 22 officers and men including one or more chiefs.

Some may observe that with outlying companies manned with only 3 or 4 men on duty, the number of companies in the city could be increased to meet Grading Schedule requirements. However, unless area makes this imperative the practice should be avoided as such weak companies will be almost useless when called to major fires that inevitably occur in large cities.

Cities of 150,000 population can provide three engines and two ladders with high-value manning of at least 6 men on duty in each company. This is only one

(OVER)

man per shift less than Grading Schedule requirements. For the remaining nine engine and three ladder companies suggested under the reduced schedule suggested above, there are not less than five men on duty with each company. A department of this size will be strong and well able to cope with two normal fires simultaneously and still maintain covering companies.

Although it may be anticipated that underwriters engineers surveying typical cities suggested here will designate more companies as high-value than has been indicated with the 1.5 formula, it may be recalled that the Grading Schedule calls for only one extra hose truck for half of the designated high-value companies. Such companies operating two pieces of apparatus would be the ones given the strongest manning.

The foregoing suggested company and platoon strengths can be summarized in the following tabulation. As pointed out a ratio of 1.3 or 1.4 can be substituted for 1.5 per 1,000 population where firemen work more than 72 hours a week.

Suggested Minimum Effective Fire Force on Duty

Population	Suggested Number Companies		High Value Engines		Low Value Engines		High Value Ladders		Low Value Ladders		Total Men On Duty. Does not Incl. Chiefs
	Eng.	Lad.	No.	Men	No.	Men	No.	Men	No.	Men	
25,000	3	1	0	0	3	12	0	0	1	3	15
50,000	5	2	1	6	4	16	0	0	2	8	30
100,000	8	3	2	12	6	30	1	6	2	10	58
150,000	12	5	3	18	9	45	2	12	3	15	90

Relation of On-Duty Fire Force to Total Manpower

Population	Manpower on a 1.5 per 1,000 Pop. Ratio	On Duty in Cos.	Two Shifts	Officers and Aides	Days Off	Relief Men Vacations and Sick Leave
25,000	37	15	30	2	5	*
50,000	75	30	60	6	9	*
100,000	150	58	116	8	18	8
150,000	225	90	180	12	27	6

In conclusion it may be stated that in general the underwriters Grading Schedule requirements are not obtainable in most cities and that a yardstick for fire fighting personnel might be set up as follows:

Fire Fighters
Per 1,000 Population

Excellent	2.00 or better.	Numerous well manned fire companies.
Fair to Good	1.50	Reasonable company strength and distribution.
Poor	1.00	Insufficient and undermanned fire companies

* In the smaller departments the practice is to hire substitutes for relief and vacation periods or to run outlying companies one man short part of time.

- 7 -

A bit of experimentation will show that the 1.5 formula will have similar application in many larger cities as well as smaller cities down to 10,000 population. However, smaller cities frequently employ part-time paid call firemen or even volunteer firemen to supplement small paid forces that would be inadequate for major fires.

Also, a word of caution should be given against indiscriminate application of the formula in situations where hazards, structural conditions, and fire experience has already made it necessary and desirable to provide stronger manual fire forces more closely approaching the full National Board Grading Schedule requirements. However, the figure does give a reasonable and obtainable manpower goal for departments that are more or less obviously deficient in manual strength.

